## SIM Chemical Metrology Working Group

## 13 October 2005 Trinidad and Tobago

## Workshop: Formulation and Review of CMCs:

# *SIM Guidelines for Formulation of CMCs for Chemical Measurements*

SISTEMA INTERAMERICANO DE METROLOGIA

**Updated: 13 October 2005**
**reenie.parris@nist.gov**

## What?

CMCs: **C**alibration and **M**easurement **C**apabilities

(reference: "Overview of CIPM MRA" presentation available on this website)

For the **normally-delivered** services to customers

## Proposed CMC Declarations Submitted By?

Country – for its NMI's and other officially-designated institutes

## Submitted To?

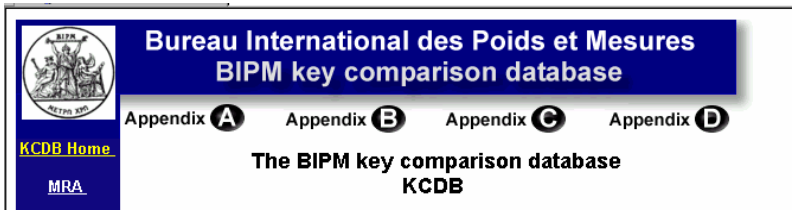
Your RMO (e.g., SIM) for intraregional review; if coded "OKAY" by RMO, RMO forwards CMC for interregional review

## How?

## When?

(ref: CMC Schedule and "CMC Review Process" presentation available on this website)

## Where published?




See published CMCs in Appendix C of the BIPM KCDB at http://kcdb.bipm.org/ site.

# CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

Excel template

## Template Fields/Subfields

| Country | NMI or Designated Service Provider | NMI Service Identifier | Meas. Serv. Cat. No. | Meas. Serv. Sub-Category No. | Meas. Serv. Category | Matrix | Measurand | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Analyte Group Identifier | Analyte or Component | CAS Number | Quantity |

| Dissemination Range of Measurement Capability | | | Range of Expanded Uncertainties as Disseminated | | | | | |
|---|---|---|---|---|---|---|---|---|
| From | To | Unit | From | To | Unit | Cov. factor | Lev. of confid. | Is the expanded uncertainty a relative one? |

| Range of Certified Values in Reference Materials | | | Range of Expanded Uncertainties for Certified Value | | | | | | Mechanism(s) for Measurement Service Delivery |
|---|---|---|---|---|---|---|---|---|---|
| From | To | Unit | From | To | Unit | Cov. factor | Lev. of confid. | Is the expanded uncertainty a relative one? | |

| Source of Traceability | Measurement Technique(s) Used | Link(s) to Appendix B (Formal Comp. Name(s)) | Comment(s) of Service Provider | Comments (to be published via the database) | Uncertainty Convention | RMO Services Administration (for RMO use only) | |
|---|---|---|---|---|---|---|---|
| | | | | | | Review Code/ Status | Review Comments |

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Template Fields/Subfields

- Country
- NMI or Designated Service Provider
- Measurement Service Category Number
- Measurement Service Sub-Category Number
- Measurement Service Category (Name)
- Matrix
- Measurand
  - Analyte Group Identifier
  - Analyte or Component
  - CAS Number
  - Quantity
- Dissemination Range of Measurement Capability
  - From
  - To
  - Unit
- Range of Expanded Uncertainties as Disseminated
  - From
  - To
  - Unit
  - Coverage factor
  - Level of confidence
  - Is the expanded uncertainty a relative one?

*These fields describe the actual measurement capability declaration.*

# Template Fields/Subfields - continued

**Range of Certified Values in Reference Materials**
- **From**
- **To**
- **Unit**

**Range of Expanded Uncertainties for Certified Value**
- **From**
- **To**
- **Unit**
- **Cov. factor**
- **Lev. of confid.**
- **Is the expanded uncertainty a relative one?**

*Use these fields only if CRM(s) are listed as a Mechanism for Delivery of the Measurement Service*

**Mechanism(s) for Measurement Service Delivery**

***Source of Traceability***

***Measurement Technique(s) Used***

***Link(s) to Appendix B (Formal Comp. Name(s))***

***Comment(s) of Service Provider***

**Comments (to be published via the database)**

**Uncertainty Convention**

***Items in purple font and italics are NOT currently shown on the published KCDB but are used in the review process.***

## Mutual Recognition Arrangement (MRA) requires:

1. Declaring and documenting calibration and measurement capabilities (CMCs)

- ***Examples*:**

| Country | NMI or Designated Service Provider | NMI Service Identifier | Meas. Serv. Cat. No. | Meas. Serv. Cat. | Matrix | Measurand | Dissemination Range of Measurement Capability | | | Range of Expanded Uncertainties as Disseminated | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | From | To | Unit | From | To | Unit | Cov. factor | Lev. of confid. |
| US | NIST | 8393018 | 4.3 | Gases: Fuel | natural gas | n-butane | 0.1 | 1.5 | %mol/mol | 1 | 2 | %rel | 2 | 95% |
| US | NIST | 8393600 | 6 | pH | aqueous pH buffer | pH | 1.7 | 13.4 | pH | 0.005 | 0.01 | pH | 2 | 95% |
| US | NIST | 8392171 | 10.1 | Biological Fluids and Materials: Blood, plasma, serum | serum | cholesterol (total) | 2.7 | 10 | mmol/L | 0.2 | 1.3 | % rel | 2 | 95% |
| US | NIST | 8391001 | 5.1 | Water: Fresh Water | water | lead | 2 | 30 | µg/kg | 0.1 | 0.6 | µg/kg | 2 | 95% |

| Range of Certified Values in Reference Materials | | | Range of Expanded Uncertainties for Certified Value | | | | | Mechanism(s) for Measurement Service Delivery | Source of Traceability | Measurement Technique(s) Used | Link(s) to Appendix B (Formal Comp. Name(s)) | Comment(s) of Service Provider |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | To | Unit | From | To | Unit | Cov. factor | Lev. of confid. | | | | | |
| 0.1 | 1.5 | %mol/mol | 1 | 2 | %rel | 2 | 95% | NTRM | NIST | GC-TCD | CCQM-K1.e,f,g; NIST/NMi 1999 DOE | NTRM: NIST Traceable Reference Material, certified based on comparison to NIST primary standard suites; (DOE = Declaration of Equivalence) |
| 1.7 | 13.4 | pH | 0.005 | 0.005 | pH | 2 | 95% | SRMs 185g, 186-I-f/186-II-f, 187d, 189b, 191b, 192b, 2181-2184, 2193 | NIST | Potentiometry | CCQM-K9; EUROMET 381 | Primary pH measurement with NIST Harned cell |
| 2.7 | 8.6 | mmol/L | 0.2 | 1.3 | % rel | 2 | 95% | SRM 909b, SRM 968c, SRM 1951a, SRM 1952a, SRM 1589a, NIST Value-Assignment of CAP Proficiency Testing Samples | NIST | ID-GCMS | CCQM-K6 | Primary method with confirmation of measurement results; CAP = US College of American Pathologists |
| 2 | 30 | µg/kg | 0.1 | 0.6 | µg/kg | 2 | 95% | SRM 1640, 1643d | NIST | ID-ICPMS | CCQM-K2 | Certification using ID-ICPMS with confirmation by second method |

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Country

- 2-letter abbreviation of country name as referenced in ISO 3166-1-Alpha-2 code element. (The complete code list is freely available on the ISO 3166 Maintenance Agency Home Page at http://www.iso.org/iso/en/prods-services/iso3166ma/index.html)
- Examples, for Argentina, enter “AR”; Brazil: “BR”; Chile: “CL”; Mexico: “MX”

### NMI or Designated Service Provider

- the organization that is responsible for the particular CMC declaration being made for a particular nation/region/economy.
- Use the official abbreviation for the National Metrology Institute (NMI) or Designated Service Provider.
- Examples, NIST, CENAM

### Measurement Service Category Number

- the integer number of the general CCQM measurement category, currently 1-15 from Table of CCQM Measurement Service Category Numbers and Categories.
- Example, if the declaration is for a measurand in sediment, then 13 would be entered in this field.

### Measurement Service Sub-Category Number

- the number with one decimal place of the measurement SUB-category from Table of CCQM Measurement Service Category Numbers and Categories.
- Example, if the declaration is for a measurand in sediment, then 13.1 would be entered in this field.

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Measurement Service Category (Meas. Serv. Cat.)

- the name of the category from Table of CCQM Measurement Service Category Numbers and Categories.
- Example, if the declaration is for a pesticide in an organic solvent, then “Pesticides” would be entered in this field.

### Matrix

- List the type of matrix/sample/substance/material for which the declaration for the specified measurand is being made.
- Examples
  - Human Serum, Sediment, Soil, Air Particulate, Food Composite, etc.
  - There are cases where this field could provide more unique information, such as:
    - for a Gas Mixtures, matrix types could be air, nitrogen, etc.
    - for Organic Solution, the matrix could be listed as a “Multicomponent hexane solution”
    - for Inorganic Solution, the matrix might be listed as“Monoelemental aqueous solution”.

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Measurand

#### Analyte Group Identifier

- This column should be left blank. It is required to allow for future modifications of the database search engine.

#### Analyte or Component

- *Particular quantity subject to measurement.* [VIM, International Vocabulary of basic and general standard terms in Metrology, ISO, Geneva, Switzerland 1993.]
- enter the individual or group of chemical species or chemical property for which the CMC declaration is being made.
- Examples:
  - Chemical specie such as: iron, phenol
  - an individual polychlorinated biphenyl congener such as PCB 153 or a mixture of PCBs, such as Aroclor 1260
  - for a high purity chemical, the measurand (property) could be “Total acid content expressed as benzoic acid”
  - for the Chemical Oxygen Demand in a contaminated water, the analyte listed could be “COD (expressed as reduction capacity of potassium biphthalate)”

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Measurand (continued)

#### CAS Number

- Chemical Abstracts Service Registry Number (CAS Registry Number) for the analyte(s) or component (s) is to be listed in this column.
- Note that typically there are different CAS numbers for elemental versus ion species, e.g., chlorine versus chloride.
- The CAS number will be used to identify all data entries within the database that are synonymous with a chosen analyte/component as the names as entered may vary
- If no CAS number is available the field should be left blank.
- Example, for benzene enter "71-43-2".

#### Quantity

- The quantity to which the claim refers must be stated, e.g. amount-of-substance fraction.
- Example of entry for "Quantity" for various units

| "Quantity" Entry | units | |
|---|---|---|
| mass fraction | mass/total mass | ng/g |
| amount-of-substance concentration | mole/total volume | mmol/L |
| mass concentration | mass/total volume | mg/L |
| amount-of-substance content or amount content | mole/total mass | mmol/kg |
| amount-of-substance fraction | mole/total mole | mmol/mol |

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Dissemination Range of Measurement Capability

**From**

**To**

**Unit**

- REQUIRED subfields
- Entries should describe the full range and units of the measurement capability declaration being made.
- Independent, autonomous CMCs may be declared for the same “measurand/matrix” combination for different dissemination ranges.
  - Instead of submitting one CMC for a broad mass fraction range with a wide range of expanded uncertainties, an NMI might choose to submit two (or more) independent CMC entries.
    - For example, a CMC might be declared for benzo[a]pyrene in soil in a range from 10 to 500 µg/kg with an expanded uncertainty of 10 to 30 % relative and an additional declaration could be made for benzo[a]pyrene in soil in a range from 500 to 5000 µg/kg with an expanded uncertainty range of 2 to 5 % relative.
    - For these cases, two or more CMC declarations are being made and the information in all relevant fields must be provided for each.
- When a service is offered at a specific level instead of a range, the level is to be entered in both the “From” and “To” subfields, in order to avoid a wrong interpretation in the sense that the minimum value is zero.

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

**Range of Expanded Uncertainties as Disseminated**
**From**
**To**
**Unit**
**Cov. factor**
**Lev. of confid.**
**Is the expanded uncertainty a relative one?**

- REQUIRED subfields
- Entries should describe the full range and units of the expanded uncertainties of the measurement capability declaration being made.
- When the expanded uncertainty is the same throughout the listed dissemination range for a specific CMC declaration, this uncertainty is to be entered in both the “From” and “To” subfields.
- For “Is the expanded uncertainty a relative one?” field, enter Yes or No in this column.
- See also the field for “Uncertainty Measurement Convention” for further guidance

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

**Range of Certified Values in Reference Materials**

**From**

**To**

**Unit**

**Range of Expanded Uncertainties for Certified Value(s) (of CRM)**

**From**

**To**

**Unit**

**Cov. factor**

**Lev. of confid.**

**Is the expanded uncertainty a relative one?**

- Use these fields **only if** CRM(s) are listed as a Mechanism for Delivery of the Measurement Service (see description of field on next slide),
- If so, then these fields are used to describe the range and units of the certified value(s) of the listed CRM(s) and of the range and units of the expanded uncertainties of these certified value(s).
- When the expanded uncertainty is for one CRM or is the same throughout the listed certified value range for a specific CRMs, this uncertainty is to be entered in both the "From" and "To" subfields.
- For "Is the expanded uncertainty a relative one?" field, enter Yes or No in this column.
- If the Measurement Service being declared is not delivered to customers via CRM(s), then these field are to be left blank.

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Mechanism(s) for Measurement Service Delivery

- List how the NMI or Designated Service Provider disseminates the measurement capability.
- For example, an NMI might use its measurement capability to value-assign proficiency testing samples, gas mixtures, etc. for customers upon demand. Another NMI might disseminate its measurement services through provision of CRMs. Other NMI's might do some of both.
- Example entries include but are not limited to specific CRM(s)s (provide unique identifier, e.g. NIST SRM 909b) or formal program(s) for value-assignment of client samples [sometimes called a "Calibration Service" or "Reference Measurement Service" [identify program(s)].

### Source of Traceability

- List official abbreviation for the NMI that provides the highest link to the SI for the CMC being declared.

### Measurement Technique(s) Used

- Identify the technique(s) used for providing the measurement capability declared.
- Provide enough information to demonstrate that capability has specificity for the measurand listed.
- Examples include IDMS, GC-FID, HPLC-UV, titrimetry (type), coulometry, neutron activation analysis, etc.
- Use the "Comment(s) of Service Provider" field to provide additional details, if necessary, to describe the linkage between the technique used and realization of the SI for the declaration being made.

## CIPM MRA Appendix C Calibration and Measurement Capability (CMC) Declarations for Chemical Measurements

# Description of Template Fields/Subfields

### Link(s) to Appendix B (Formal Comp. Name(s))

- This field should contain the name of any CCQM key or supplementary comparison(s) in which the NMI or Designated Service Provider submitting the service has participated that support the measurement capability being declared.

### Comment(s) of Service Provider

- Used to provide any brief, additional comments that will assist your RMO and/or CCQM KCWG (for interregional review) in reviewing the specific CMC declaration.
- Example, list any CCQM pilot comparisons or RMO comparisons that support the measurement capability being declared.

### Comments (to be published via the database)

- Rarely used, information listed here will be published with CMC

### Uncertainty Range Convention (for Measurement Capability as disseminated)

- Enter “Convention 1” when the expanded uncertainty range spans from the smallest numerical value of the uncertainty to the largest numerical value of the uncertainty found within the quantity range.
- Enter “Uncertainty Range Convention 2” when the expanded uncertainty range is expressed as the uncertainty of the smallest value of the quantity to the uncertainty of the largest value of the quantity; I.e., there is a link between the “from” entries and a link between the “to” entries for the dissemination range and the expanded uncertainty range.

# Additional general formatting instructions:

- Use EXCEL file for NMI submission of chemical measurement CMC declarations to RMO. See next slide for instructions as to naming of file and of worksheets within the file.
- Translate all words into English.
- Avoid use of excess number of significant figures in the Dissemination Range entries and the associated Expanded Uncertainties
- Complete one row of fields for each CMC declaration.
- Each CMC declaration should “stand alone”, I.e., complete needed fields for each CMC.
- Do not add footnotes. Use the specified “Comments” field for additional information.
- Do not modify content of field headings, insert additional columns or headings, etc.
- Do not merge any cells.
- Do not imbed returns, spaces or tabs in a single cell to force word wrapping.
- “Use only the native Microsoft Symbol font” was original “rule” but have found it is best to writeout symbol in many cases, especially for “micro” as in microg instead of using µg – have had a number of cases where µ became “m” – leading to confusion when reviewing/publishing of a CMC.
- Do not use ± in the range or uncertainty fields.
- Use the 'dot/period' as a decimal separator rather than a 'comma'
- Try to avoid exponents, but if they are needed, convert from Y x 10-XX to YE-XX.

# Naming/Formatting of Files for Submission of CMCs to SIM

- **CMCs should be submitted in an EXCEL workbook (one workbook per country) named as: "SIM_QM_*CC_Date*.xls"**

  Where,
  - QM is the acronym for "Amount of Substance"
  - CC is the two letter country code
  - Date is date submitted and is written as "ddmmmyy", where "dd" is the day of the month, "mmm" is the 3 first letters of the month, and "yy" the 2-digit year.

  Example: SIM_QM_MX_09Apr01.xls

- **Submitted CMCs should be grouped by country with CMCs for each major Measurement Service Category on a separate worksheet within the Excel workbook**.
  - ❖ **Complete "Date" and CMC Cycle" on each sheet; Date should be updated for any submitted revisions**
  - ❖ **Each sheet should be named as: CC_CatNumber, e.g., MX_06**

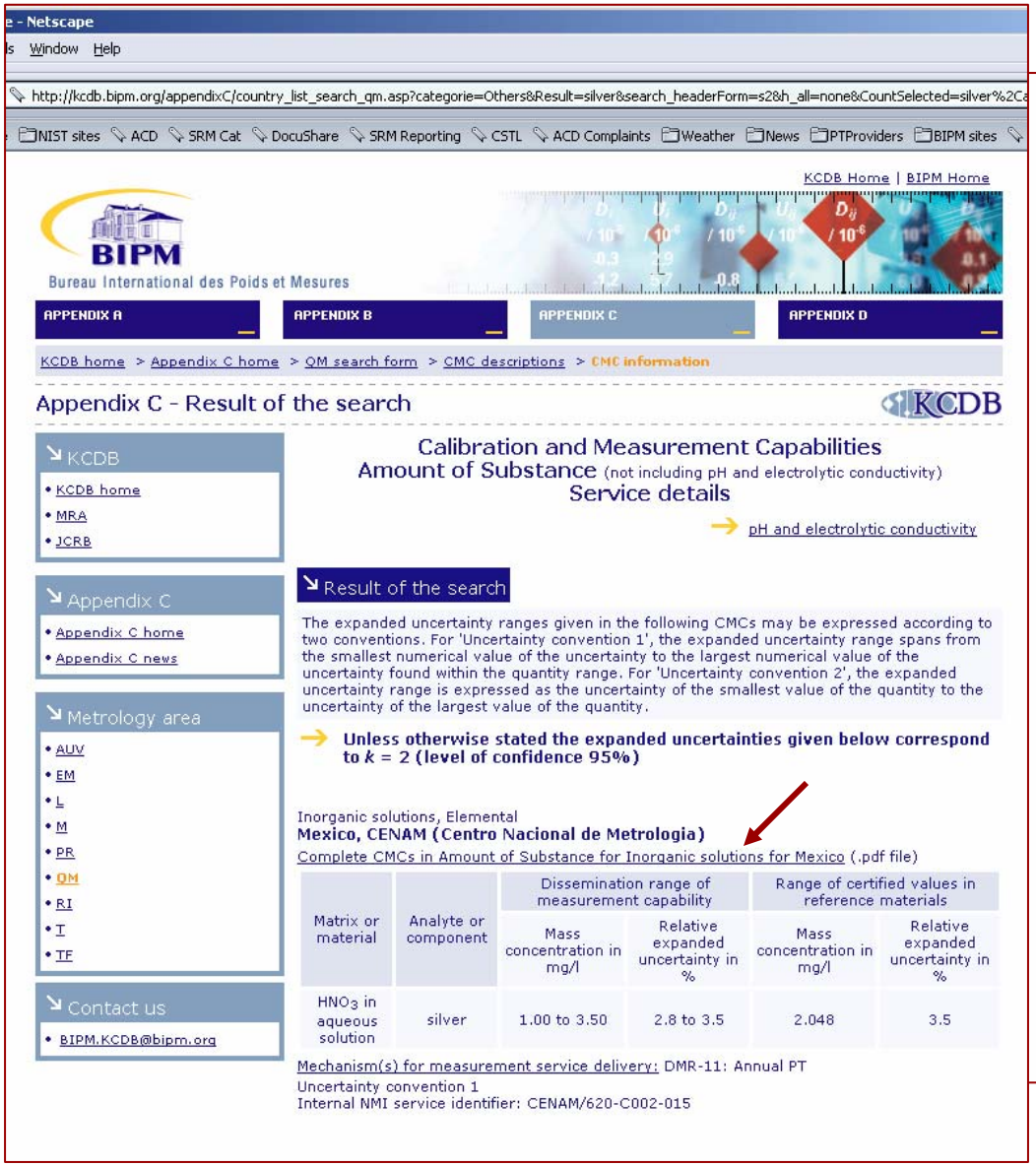
  Where,
  - CC is the two letter country code
  - CatNumber is the number from "01" to "15" corresponding to the following Measurement Service Categories:

    01: High Purity Chemicals
    02: Inorganic Solutions
    03: Organic solutions
    04: Gases
    05: Water
    06: pH
    07: Electrolytic Conductivity
    08: Metals and Metal Alloys
    09: Advanced Materials
    10: Biological Fluids and Materials
    11: Food
    12: Fuels
    13: Sediments, Soils, Ores and Particulates
    14: Other Materials
    15: Photometric Properties

- **In the case where more than one Measurement Service Category may apply to a given CMC, the CMC can be repeated (verbatim) in each applicable category.**

# Example: Results of CMC search > QM > Inorganic Solution > Silver

## Website to start QM search: http://kcdb.bipm.org/appendixC/search.asp?met=QM




Inorganic solutions, Elemental

**Slovakia (Slovak Republic), SMU (Slovensky Metrologicky Ustav)**

Complete CMCs in Amount of Substance for Inorganic solutions for Slovakia (Slovak Republic) (.pdf file)

| Matrix or material | Analyte or component | Dissemination range of measurement capability | | Range of certified values in reference materials | |
|---|---|---|---|---|---|
| | | Mass concentration in g/l | Relative expanded uncertainty in % | Mass concentration in g/l | Relative expanded uncertainty in % |
| mono-elemental solution | silver | 0.5 to 10 | 0.2 to 0.1 | 0.98 to 1.01 | 0.2 |

Mechanism(s) for measurement service delivery: CRM B01
Uncertainty convention 2
Internal NMI service identifier: SMU/I-10-16

Inorganic solutions, Elemental

**United States, NIST (National Institute of Standards and Technology)**

Complete CMCs in Amount of Substance for Inorganic solutions for United States (.pdf file)

| Matrix or material | Analyte or component | Dissemination range of measurement capability | | Range of certified values in reference materials | |
|---|---|---|---|---|---|
| | | Mass fraction in mg/kg | Relative expanded uncertainty in % | Mass fraction in mg/g | Absolute expanded uncertainty in mg/g |
| acidic solution | silver | 0.5 to 15000 | 0.5 to 0.3 | 10.01 | 0.03 |

Mechanism(s) for measurement service delivery: SRM 3151, QA for Providers of Water Quality Proficiency Testing as described in NIST NVLAP Handbook 150-19
Uncertainty convention 2
Internal NMI service identifier: NIST/8391148

Water, Fresh water

**United States, NIST (National Institute of Standards and Technology)**

Complete CMCs in Amount of Substance for Water for United States (.pdf file)

| Matrix or material | Analyte or component | Dissemination range of measurement capability | | Range of certified values in reference materials | |
|---|---|---|---|---|---|
| | | Mass fraction in ng/g | Absolute expanded uncertainty in ng/g | Mass fraction in ng/g | Absolute expanded uncertainty in ng/g |
| acidic solution | silver | 1 to 500 | 0.05 to 5 | 1.25 to 7.62 | 0.06 to 0.25 |

Mechanism(s) for measurement service delivery: SRM 1640, SRM 1643d
Uncertainty convention 1
Internal NMI service identifier: NIST/8391216

# From link shown with arrow on previous slide

Calibration and Measurement Capabilities

**Amount of substance, inorganic solutions, Mexico, CENAM (Centro Nacional de Metrologia)**

Note: In the case where an uncertainty range is given, the expanded uncertainty range spans from the smallest numerical value of the uncertainty to the largest numerical value of the uncertainty found within the quantity range.

| NMI Service Identifier | Measurement Service Sub-Category | Matrix | Measurand | | Dissemination Range of Measurement Capability | | | Range of Expanded Uncertainties as Disseminated | | | | | | Range of Certified Values in Reference Materials | | | Range of Expanded Uncertainties for Certified Value | | | | | | Mechanism(s) for Measurement Service Delivery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Analyte or Component | Quantity | From | To | Unit | From | To | Unit | Coverage factor | Level of confidence | Is the expanded uncertainty a relative one? | From | To | Unit | From | To | Unit | Coverage factor | Level of confidence | Is the expanded uncertainty a relative one? | |
| 620-Q008-008 | Elemental | $HNO_3$ in aqueous solution | mercury | Mass concentration | 5.0 | 25.0 | µg/l | 3.7 | 3.5 | % | 2 | 95% | Yes | 10.04 | 10.04 | µg/l | 3.6 | 3.6 | % | 2 | 95% | Yes | DMR-2: Annual PT |
| 620-C007-01 | Elemental | aqueous solution | chromium (VI) | Mass concentration | 0.10 | 4.00 | mg/l | 3.5 | 4.2 | % | 2 | 95% | Yes | 1.623 | 1.623 | mg/l | 3.5 | 3.5 | % | 2 | 95% | Yes | DMR-3: Annual PT |
| 620-C002-008 | Elemental | $HNO_3$ in aqueous solution | aluminum | Mass concentration | 9.0 | 20.0 | mg/l | 3.3 | 3.5 | % | 2 | 95% | Yes | 12.403 | 12.403 | mg/l | 3.3 | 3.3 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-009 | Elemental | $HNO_3$ in aqueous solution | cadmium | Mass concentration | 0.5 | 2.0 | mg/l | 3.5 | 2.8 | % | 2 | 95% | Yes | 0.946 | 0.946 | mg/l | 3.5 | 3.5 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-010 | Elemental | $HNO_3$ in aqueous solution | copper | Mass concentration | 1.5 | 4.0 | mg/l | 2.6 | 3.6 | % | 2 | 95% | Yes | 1.944 | 1.944 | mg/l | 3.6 | 3.6 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-011 | Elemental | $HNO_3$ in aqueous solution | chromium | Mass concentration | 1.8 | 5.0 | mg/l | 3.1 | 7.5 | % | 2 | 95% | Yes | 1.931 | 1.931 | mg/l | 3.8 | 3.8 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-012 | Elemental | $HNO_3$ in aqueous solution | nickel | Mass concentration | 0.7 | 2.0 | mg/l | 3.7 | 5.8 | % | 2 | 95% | Yes | 0.901 | 0.901 | mg/l | 4.2 | 4.2 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-013 | Elemental | $HNO_3$ in aqueous solution | lead | Mass concentration | 1.0 | 15.0 | mg/l | 1.7 | 3.5 | % | 2 | 95% | Yes | 9.904 | 9.904 | mg/l | 3.5 | 3.5 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-014 | Elemental | $HNO_3$ in aqueous solution | zinc | Mass concentration | 0.25 | 1.50 | mg/l | 3.2 | 5.8 | % | 2 | 95% | Yes | 0.398 | 0.398 | mg/l | 3.2 | 3.2 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-Q008-009 | Elemental | $HNO_3$ in aqueous solution | arsenic | Mass concentration | 0.10 | 1.00 | mg/l | 3.5 | 8.1 | % | 2 | 95% | Yes | 0.163 | 0.163 | mg/l | 3.5 | 3.5 | % | 2 | 95% | Yes | DMR-8: Annual PT |
| 620-C002-015 | Elemental | $HNO_3$ in aqueous solution | silver | Mass concentration | 1.00 | 3.50 | mg/l | 2.8 | 3.5 | % | 2 | 95% | Yes | 2.048 | 2.048 | mg/l | 3.5 | 3.5 | % | 2 | 95% | Yes | DMR-11: Annual PT |
| 620-Q014-001 | Elemental | $HNO_3$ in aqueous solution | copper | Mass concentration | 950 | 1050 | mg/l | 0.6 | 0.6 | % | 2.78 | 95% | Yes | 999.1 | 999.1 | mg/l | 0.6 | 0.6 | % | 2.78 | 95% | Yes | DMR 17 |
| 620-Q014-002 | Elemental | $HNO_3$ in aqueous solution | nickel | Mass concentration | 950 | 1050 | mg/l | 0.8 | 0.8 | % | 2 | 95% | Yes | 1002.8 | 1002.8 | mg/l | 0.8 | 0.8 | % | 2 | 95% | Yes | DMR-40 |
| [illegible] | [illegible] | $HNO_3$ in aqueous | [illegible] | Mass | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# Partial Examples for discussion points:

| Meas.Ser.Sub-Category No. | Matrix | Measurand | | | | ... | Measurement Technique(s) Used |
|---|---|---|---|---|---|---|---|
| | | Analyte Group Identifier | Analyte or Component | CAS Number | Quantity | | |
| Inorganic solutions | mono-elemental aqueous solution | | Copper | 7440-50-8 | Mass fraction | ... | ID-ICPMS |
| High purity chemicals | high purity potassium dichromate | | oxidants expressed as potassium dichromate | 7778-50-9 | Mass fraction | ... | Coulometry |
| High purity chemicals | high purity potassium chloride | | total halides (except F) expressed as potassium chloride | 7447-40-7 | Mass fraction | ... | Coulometry |

# **Partial** Examples for discussion points:

| Meas.Ser.Sub-Category No. | Matrix | Measurand | | | | Mechanism(s) for Measurement Service Delivery | Measurement Technique(s) Used |
|---|---|---|---|---|---|---|---|
| | | Analyte Group Identifier | Analyte or Component | CAS Number | Quantity | | |
| Inorganic solutions | mono-elemental aqueous solution | | nickel | 7440-02-0 | Mass fraction | Calibration service for samples of known origin | titrimetry (excess EDTA titrated with 0.01 mol/L-Pb) |

# Current CCQM Measurement Service Category Numbers and Categories

**1 High Purity Chemicals**
1.1 Inorganic Compounds
1.2 Organic Compounds
1.3 Metals
1.4 Isotopics
1.5 Other

**2 Inorganic Solutions**
2.1 Elemental
2.2 Anionic
2.3 Other

**3 Organic Solutions**
3.1 PAHs
3.2 PCBs
3.3 Pesticides
3.4 Other

**4 Gases**
4.1 High Purity
4.2 Environmental
4.3 Fuel
4.4 Forensic
4.5 Medical
4.6 Other

**5 Water**
5.1 Fresh Water
5.2 Contaminated Water
5.3 Sea Water
5.4 Other

**6 pH**

**7 Electrolytic Conductivity**

**8 Metals and Metal Alloys**
8.1 Ferrous Metals
8.2 Non-Ferrous Metals
8.3 Precious Metals
8.4 Other

**9 Advanced Materials**
9.1 Semiconductors
9.2 Superconductors
9.3 Polymers and Plastics
9.4 Ceramics
9.5 Other

**10 Biological Fluids and Materials**
10.1 Blood, Plasma, Serum
10.2 Urine Fluids
10.3 Hair
10.4 Tissues
10.5 Bone
10.6 Botanical Materials
10.7 Other

**11 Food**
11.1 Nutritional Constituents
11.2 Contaminants
11.3 GMOs
11.4 Other

**12 Fuels**
12.1 Coal and Coke
12.2 Petroleum Products
12.3 Bio-mass
12.4 Other

**13 Sediments, Soils, Ores, and Particulates**
13.1 Sediments
13.2 Soils
13.3 Ores
13.4 Particulates
13.5 Other

**14 Other Materials**
14.1 Cements
14.2 Paints
14.3 Textiles
14.4 Glasses
14.5 Thin Films
14.6 Coatings
14.7 Insulating Materials
14.8 Rubber
14.9 Adhesives
14.10 Other

**15 Photometric Properties**

↺ Return